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(54) IMPROVEMENTS IN OR RELATING TO ELECTRICAL MACHINES

(71) We, ROBERT BOSCH GmbH, a German Company, of Postfach 50, 7000 Stuttgart 1, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The invention relates to electrical machines.

Generators are known which comprise claw-pole rotors, a magnetic flux being fed to the rotatable claws by a fixed excitation system by way of interposed air gaps. The rotatable claws have to be magnetically separated from one another. Various problems arise when manufacturing the rotor for an electrical machine of this type. One problem is that individual claws bend outwardly at high rotational speeds and thus not only reduce the air gap between the claws and the stator laminations but can even come into contact with the stator lamination, thus leading to destruction of the machine within a short period of time. Therefore, it is important to make the claws as rigid as possible relative to the pole core to which they are secured. On the other hand, however, it is very difficult to secure an overhung pole ring to a cup-shaped pole ring. The bending of the claws at high rotational speeds can loosen the connection means, which can also cause the destruction of the machine within a short period of time.

According to the present invention there is provided a slipringless electrical machine comprising a stator pole assembly, a claw-pole rotor assembly rotatable within the stator pole assembly, and a fixed excitation system including an excitation winding, the claw-pole rotor assembly having a pole disc, a first pole ring mechanically and magnetically connected to the pole disc, and a second pole ring which is only mechanically connected to the first pole ring, the fixed excitation system cooperating at least indirectly with the pole disc and with the second pole ring, each pole ring comprising a plurality of claws and bridge portions between the claws, at least one of the pole rings being formed from a strip.

A particular advantage is that the rotor of the machine in accordance with the invention can be manufactured, particularly mass-produced, in an inexpensive and simple manner. It is particularly advantageous that the centrifugal forces occurring during rotation of the rotor can be controlled satisfactorily, and the connection between the individual pole rings can be very stable.

An electrical machine embodying the present invention may be a three-phase alternator for motor vehicles, particularly in a new generation of motor vehicle engines which have a different vibratory behaviour and/or greater durability than conventional engines, for example in conjunction with turbines. Furthermore, a machine embodying the present invention can be operated to advantage in a mechanically or chemically hostile atmosphere.

The invention will hereinafter be further described by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is partially sectioned illustration, in diagrammatic form of the slipringless motor vehicle alternator constructed according to one embodiment of the invention,

Fig. 2a is an end view of one arrangement of a pole disc with attached pole ring,

Fig. 2b is an axial cross sectional view of the pole disc and pole ring of Fig. 2a,

Fig. 3 illustrates a stage in the manufacture of one arrangement of two claw-pole rings for a machine and shows two strips of metal comprising claws each joined to a respective bridge portion of the other strip by a respective non-magnetic member,

Fig. 4 illustrates a stage in the manufacture of a second arrangement of two claw-pole rings from metal strips in which claws of the strips are mechanically inter-connected by a

strip of non-magnetic material,

Fig. 5 illustrates a stage in the manufacture of a third arrangement of two claw-pole rings from metal strips in which claws of the strips are mechanically inter-connected by means of non-magnetic intermediate members,

Fig. 6 is a part cross sectional view of a rotor, for a machine in which the claws of the pole rings are joined in the manner shown in Fig. 3,

Fig. 7a is an end elevation of a rotor in which the claws of the pole rings are joined in the manner shown in Fig. 4,

Fig. 7b is an axial cross section through the rotor of Fig. 7a, and

Fig. 8 is a partially sectioned illustration of a slipringless motor vehicle alternator constructed according to a further embodiment of the invention in which the excitation winding is secured to a bearing plate.

Referring to Fig. 1 an alternator housing includes a bearing plate 11 at the drive end and a bearing plate 12 at the end remote from the drive end. A stator 13 is clamped between the bearing plates 11 and 12. The stator 13 carries a phase winding 14. The bearing plate 12 carries an excitation system having a ring 15 and an excitation winding 16. A shaft 17 is journalled in the bearing plates 11 and 12 and carries a core 18, a first pole ring 19 mounted on a pole disc 20, and a second pole ring 21. The core 18 is cylindrical and integral with the pole disc 20. The ring 15 the excitation system cooperate with the second pole ring 21 and with the core 18 and the pole disc 20 and therethrough with the first pole ring 19. Furthermore, a cooling plate 22 having rectifier diodes 23, and a voltage regulator 24 are mounted on the bearing plate 12. Only a single diode 23 is shown in Fig. 1; six main current diodes and three excitation current diodes are normally required for a three-phase alternator. Furthermore, a circuit board 25 is provided. The circuit board 25 carries conductor paths (not illustrated in Fig. 1) which serve to connect the ends 26 of the phase winding to the associated electrodes of the diodes 23. Furthermore, the circuit board 25 carries a pressure tag 27 which, when the alternator is assembled, is in contact with a corresponding pressure tag 28 on the voltage regulator 24 and establishes an electrical connection between the voltage regulator 24 and the circuit board 25. The ends 31 of the excitation winding 16 are also connected to associated contacts on the circuit board 25.

Fig. 2 shows a pole disc 20 having a first pole ring 19. Advantageously, for the purpose of improved ventilation, the pole ring 20 has recesses 35 in the region of the gaps 33 between the claws 34. It will be seen that the first pole ring 19 is manufactured from a strip (details of this are given below with reference to Fig 3), which is then bent together and welded at joint 36 by means of a first welded seam 37. After the first pole ring 19 has been bent together, welded and gauged, the first pole ring 19 is slipped onto or pressed onto the pole disc 20 and is welded by means of a second welded joint 39 in the region of ribs 38 provided below the claws 34.

Fig. 3 shows the blank of two claw-pole rings 19, 21 still existing in the form of strips. Non-magnetic intermediate members 43 are interposed between the claws 34 of the first pole ring 19 and the intermediate bridge portion 42 of the second pole ring 21. In the same manner, non-magnetic intermediate members 46 are interposed between the tips of the claws 44 of the second pole ring 21 and the intermediate bridge portion 45 of the first pole ring 19. By way of example, the intermediate members 43, 46 may be welded, soldered, glued or riveted.

In Fig. 4 there is illustrated a variant of the construction of Fig. 3. In this instance, the claws 34 and 44 of the first and second pole rings 19 and 21 are interconnected by means of a non-magnetic strip 47. As is shown in Fig. 7, the strip 47 can be inserted into grooves formed in the claws 34 and 44 of the first and second pole rings 19 and 21. The strip 47 is also bent to form a ring when the pole rings 19 and 21 are bent together and, like the pole rings 19 and 21, is welded to form a ring.

Fig. 5 shows how the two pole rings 19 and 21 are inter-connected by means of non-magnetic intermediate members 48 interposed between the mutually facing flanks 34 and 44 of the first pole ring 19 and the second pole ring 21 respectively.

Thus, in the first instance, the intermediate bridge portions 42 and 45 and the claws 34 and 44 are manufactured from a strip by punching operations, the two excitation yokes 42 and 45 are interconnected by inserting the non-magnetic connection means 43, 46, 47 and 48 during the punching operations or thereafter, and finally, the strip-shaped structures are bent to form rings and, for example, welded. The non-magnetic connection means 43, 46, 47 and 48 can be secured to the pole rings 19 and 21 by, for example, glueing, welding, soldering or riveting. Finally, as is shown in Fig. 2, the unit comprising the pole rings 19 and 21 is mounted onto the pole disc 20.

Fig. 6 shows a finished rotor in which non-magnetic intermediate members 43 are interposed between the tips of the flanks 34 of the first pole ring 19 and the excitation yoke 42 of the second pole ring 21. According to the stress which will be present in operation, further non-magnetic intermediate members 46 may be interposed between the tips of the claws 44 of the second pole ring 21 and the excitation yoke 45 of the first pole ring 19. The pole disc 20 is contiguous

with the cylindrical core 18.

Fig. 7a shows an end elevation and Fig. 7b shows a section through a rotor in which the claws 34 and 44 of the two pole rings 19 and 21 are inter-connected by means of a non-magnetic ring 47. The ring 47 is inserted into a groove 49.

Alternatively, the excitation winding may be secured to the bearing plate 11, the connections of the excitation winding being led to the circuit board 25 through a passage in the two bearing plates 11 and 12. This is shown in Fig. 8.

In the complete specification of our copending patent application No. 44748/76 (serial No. 1560746) we have claimed a slipringless electrical machine comprising a stator pole assembly, a claw-pole rotor assembly rotatable within the stator assembly, a rotor bearing at each end of the claw-pole rotor assembly, and a fixed excitation system which includes an excitation ring and an excitation winding, the claw-pole rotor assembly comprising an integral pole core and pole carrier disc manufactured from a single peice of metal, and a stub shaft connected to the pole core at one end thereof and journalled in the respective bearing.

WHAT WE CLAIM IS:-

1. A slipringless electrical machine comprising a stator pole assembly, a claw-pole rotor assembly rotatable within the stator pole assembly, and a fixed excitation system including an excitation winding, the claw-pole rotor assembly having a pole disc, a first pole ring mechanically and magnetically connected to the pole disc, and a second pole ring which is only mechanically connected to the first pole ring, the fixed excitation system cooperating at least indirectly with the pole disc and with the second pole ring, each pole ring comprising a plurality of claws and bridge portions between the claws, at least one of the pole rings being formed from a strip.

2. A machine as claimed in claim 1, in which the or each pole ring formed from a strip comprises a ring bent from the strip after claws have been punched from the strip, and having a welded joint.

3. A machine as claimed in claim 1, in which each of the first and second pole rings is formed of a strip, which strips are mechanically inter-connected by non-magnetic connection means after the laws have been punched from the strip and are then bent to form a common ring and the joints are welded.

4. A machine as claimed in claim 2, in which the first pole ring is formed of a punched strip and in which the pole disc is integral with or contiguous with a cylindrical core and is pressed into the bent and welded first pole ring.

5. A machine as claimed in claim 4, in which the pole disc and the first pole ring are welded together.

6. A machine as claimed in any preceding claim, in which tips of the claws of the first pole ring are each connected to respective bridge portions of the second pole ring by way of respective non-magnetic intermediate members.

7. A machine as claimed in any preceding claim, in which tips of the claws of the second pole ring are each connected to respective bridge portions of the first pole ring by way of respective non-magnetic intermediate members.

8. A machine as claimed in any of claims 1 to 5, in which flanks of the claws of the first pole ring and of the second pole ring are inter-connected by way of non-magnetic intermediate members.

9. A machine as claimed in claim 4 or 5, in which the inside faces of the claws of the two pole rings, which faces face the core, have at least one groove into which is inserted a ring of non-magnetic material which is mechanically and rigidly connected to the claws.

10. A machine as claimed in any preceding claim, which is a slipringless three phase alternator for a motor vehicle.

11. A slipringless alternator constructed and arranged and adapted to operate substantially as hereinbefore particularly described with reference to and as illustrated in Fig. 1 of the accompanying drawings.

12. An electrical machine constructed and arranged and adapted to operate substantially as hereinbefore particularly described with reference to Figs. 2a and 2b of the accompanying drawings.

13. An electrical machine constructed and arranged and adapted to operate substantially as hereinbefore particularly described with reference to Figs. 3 and 6 of the accompanying drawings.

14. An electrical machine constructed and arranged and adapted to operate substantially as hereinbefore particularly described with reference to Figs. 4, 7a and 7b of the accompanying drawings.

15. An electrical machine constructed and arranged and adapted to operate substantially as hereinbefore particularly described with reference to Fig. 5 of the accompanying drawings.

16. A slipringless alternator constructed and arranged and adapted to operate substantially as illustrated in Fig. 8 of the accompanying drawings.

W.J. THOMPSON & CO.
Coopers Building,
Church Street,
Liverpool. L1 3AB
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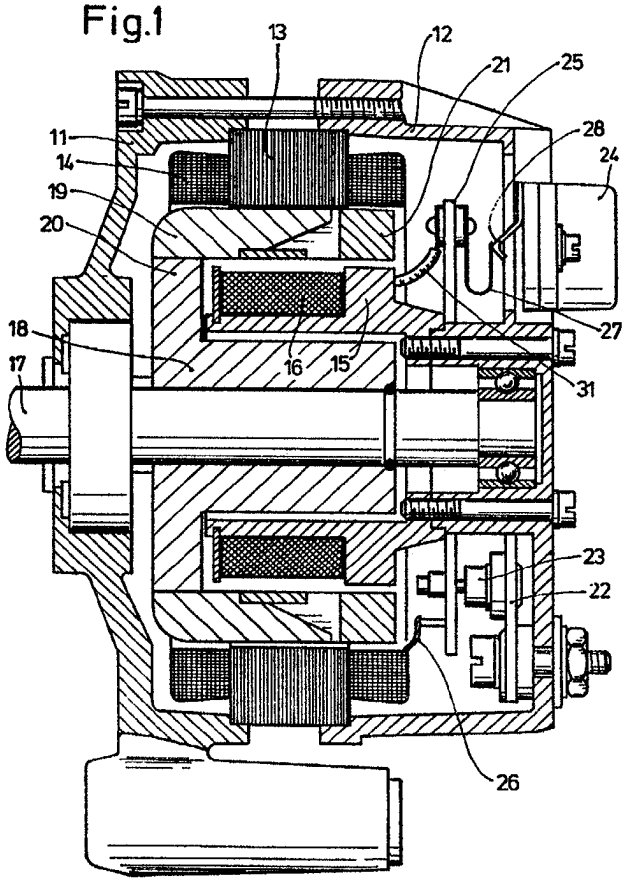
1560747 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

Fig.1



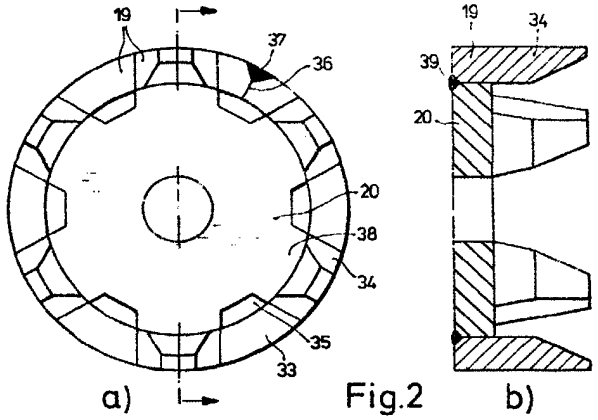


Fig.2

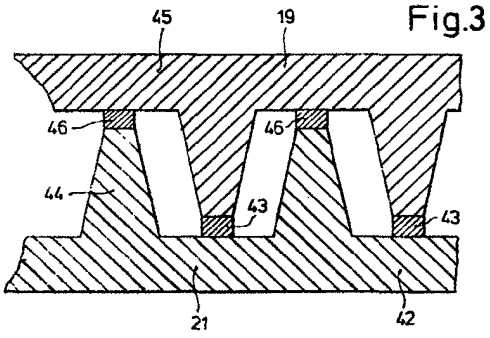


Fig.3

1560747 COMPLETE SPECIFICATION
5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 3

Fig.4

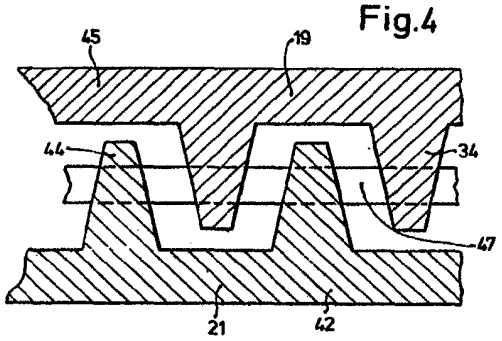


Fig.6

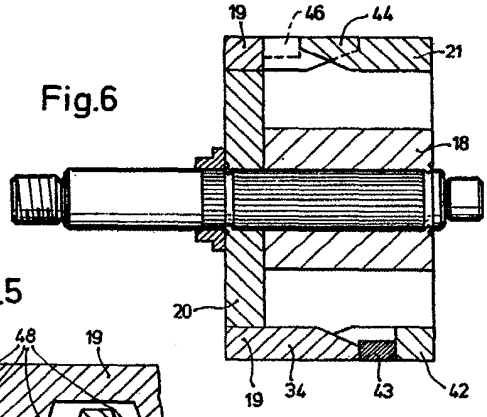
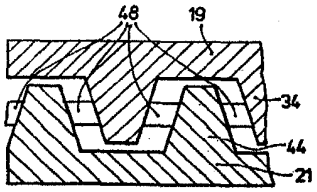


Fig.5



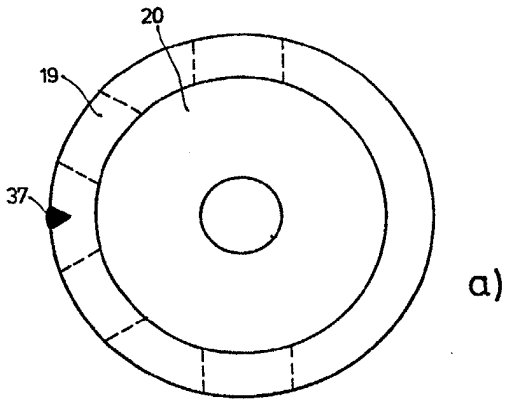


Fig.7

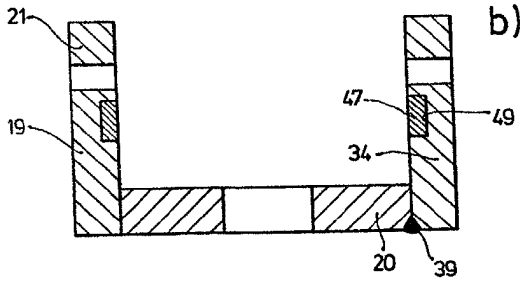


Fig.8